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ABSTRACT

Arguing that transformative teacher professional development may require more than a shift in the content of teachers' thinking, this paper examines how the structure of teachers' meaning-making systems might affect their experiences in three mathematics teacher professional development programs. The paper describes the change goals of three teacher professional development programs and their methods for accomplishing those goals. SummerMath for Teachers attempts to support a shift in teachers' paradigms about mathematics and learning by asking them to personally engage with and reflect on mathematics and pedagogy. The Math Case Methods Project supports teachers in re-evaluating and complicating their ideas about mathematics and mathematics teaching through collaborative inquiry into practice via mathematics teaching cases. The Algebra Project seeks to change the expectations of teachers, students, and the broader community about who can learn mathematics through community organizing and introduction of new curricular approaches. This study explores how the change goals and methods of the three courses might be experienced by teachers seeing through the lenses of several developmentally different perspectives posited by the theory of Robert Kegan (1982; 1994). It explains that differences in developmental frames may result in vastly different experiences within the same program. Finally, the paper raises questions about the implications of bringing an adult developmental perspective to bear on both research and teacher education practice. (Contains 56 references.) (SM)

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Towards an Understanding of Development in Transformational Teacher Education

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Abstract

Arguing that transformative teacher professional development may require more than a shift in the *content* of teachers' thinking, this paper examines how the *structure* of teachers' meaning-making systems might affect their experiences in three mathematics teacher professional development programs. This speculative paper explores how the change goals and methods of SummerMath for Teachers, the Math Case Methods Project, and the Algebra Project, might be experienced by teachers seeing through the lenses of several developmentally different perspectives posited by the theory of Robert Kegan (1982; 1994). Finally, the paper raises questions about the implications of bringing an adult developmental perspective to bear on both research and teacher education practice.

Introduction

Teaching is no longer seen as primarily a set of skills and techniques to be efficiently applied to produce pre-specified, often externally imposed objectives. Rather, it is increasingly characterized as a complex practice situated in time and place; a practice requiring careful, ongoing judgment, and the ability to balance and manage several, often divergent, perspectives and sets of values (Ball, 1993; Lampert, 1985; McDonald, 1992; Sassi & Goldsmith, 1996).

Effective professional development for teachers engaged in this complex practice must offer more than just an opportunity to acquire new technical skills and knowledge; it must also promote reflection and a stance of inquiry (Hargreaves & Fullan, 1992; Zeichner, 1983). This deeper and richer kind of professional development is often described as *transformative*.

Yet transformative teacher education has a variety of meanings to its many practitioners and researchers. For example, it can involve a re-examination of epistemological perspectives, of the nature of subject matter, or of pedagogical content knowledge (Hammer, 1995; Peterson, Fennema, Carpenter, & Loef, 1989; Prawat, 1992; Schifter,

1995; Shulman, 1987). Or, it can mean reflection on the purposes of education, moral issues, or the structures of power and authority in the classroom and the larger society (Freire, 1970; Giroux & McLaren, 1996; Harrington & Quinn-Leering, 1996). Transformative teacher education can also mean a more personal, psychological or biographical examination of deeply held beliefs and attitudes (Diamond, 1991; 1993; Raymond, Butt, & Townsend, 1992). Several authors would assert that all of these "perspective transformations" require critical reflection on one's assumptions in a specific realm, examination of the origin of these assumptions and possible alternative perspectives, and the ability to make new choices based on these insights (Brookfield, 1987; Cranton, 1996; Mezirow, 1989; 1991).

This kind of professional learning is difficult, takes time, and requires a variety of supports (Brookfield, 1987; Fullan & Stiegelbauer, 1991; Hargreaves & Fullan, 1992; Schifter & Fosnot, 1993). However, theories of adult development would claim that the demands of transformative programs may go further still; stepping outside of one's assumptions and considering several perspectives at once in light of some deeper underlying framework requires particular developmental capacities that many adults may not currently have (Belenky, Clinchy, Goldberger, & Tarule, 1986; Kegan, 1982; 1994; King & Kitchener, 1994; Loevinger & Blasi, 1976; Perry, 1970). This implies that transformative professional development programs may have inappropriate expectations for their teacher-participants.

At the same time, professional development programs do not use measures of developmental capacity as an admission screen for participants; teachers sign onto such programs across a wide range of developmental positions, and these positions may strongly affect how the demands and supports of transformative programs are experienced.

It is the potential match or mismatch between 1) the demands and supports offered by teacher professional development programs that seek transformative goals, and 2) the perspectives that teachers might bring to these programs from across a range of likely

developmental positions, that I will explore in this paper. This analysis will be theoretical, examining the stated goals and descriptions of the curricula of several transformative teacher professional development programs from a few theoretically posited developmental positions. My intention is neither to evaluate programs, nor to develop empirically-based descriptions of teachers' experiences in these programs. Rather, I hope to use an adult-developmental lens to raise new questions about the nature and effectiveness of transformative teacher professional development programs for a range of developmental categories describing their likely teacher-participants.

Method

This review and analysis is not meant to be exhaustive. In fact, because "transformative teacher professional development" encompasses such a wide range of programs, I choose to limit this paper to several, nationally known, elementary and middle grades mathematics teacher professional development programs for currently practicing teachers. In part, this choice reflects my own experiences and interests as a mathematics teacher educator. However, it also serves an essential focusing purpose—by limiting the study to mathematics programs, I will sharpen the focus on differences in goals and educational methods (simultaneously reducing the focus on differences in subject content), and will take advantage of the variety and depth of work that has been generated nationally in mathematics since the release of large-scale reform documents a decade ago (National Council of Teachers of Mathematics (NCTM), 1989; 1991; 1995; National Research Council, 1989). I choose to focus on in-service rather than pre-service programs because I am interested in teachers' ongoing, lifelong learning in the complex domain of teaching; and in transformative programs' expectations for teachers across the life-span rather than solely for the typically younger pre-service cohort.[1]

[1] I do not assume that adult development is strictly determined by age, nor that all new teachers are younger than their more experienced peers. Nonetheless, a professional development program for practicing teachers will likely require attention to a wider range of cognitive capacities than would a pre-service program.

I begin by elaborating my theoretical/ developmental frame and describing the several developmental positions that will form the basis for my analysis. I then briefly describe three professional development programs—SummerMath for Teachers, the Mathematics Case Methods Project, and the Algebra Project—focusing specifically on their change goals and their methods for supporting teachers in reaching these goals. Finally, I integrate these two descriptions, examining how teachers at different developmental levels might experience the challenges and supports that form the heart of these programs. While this discussion is primarily theoretical, I also take as a more grounded case the description of the extended change process of Sherry Sajdak, a teacher in the SummerMath for Teachers program (Schifter & Fosnot, 1993, pp. 104-118). I end with a discussion of possible implications of this analysis for research and teacher education practice.

Theories of Development

A developmental analysis of professional development programs has been little explored. While many transformative programs implicitly foster adult development by simultaneously supporting and challenging teachers to reflect critically on their teaching within a community of practice, only a few teacher education programs overtly seek cognitive developmental changes (e.g., Bell & Gilbert, 1994; Glassberg & Oja, 1981; Oja & Ham, 1984). Several other researchers attend explicitly to issues of adult development, along with other issues, in understanding the effectiveness of teacher professional development programs (Evans & Hopkins, 1988; Leithwood, 1990; McKibbin & Joyce, 1980; Sprinthall, Reiman, & Thies-Sprinthall, 1996).

Cooney & Shealy (1997) have recently raised issues of adult development in the context of mathematics education reform, stating that "reform of the sort suggested by the NCTM *Standards* requires a relativistic orientation" that allows teachers to "see the world in contextual terms, to appreciate that other perspectives are possibilities" (p. 104). Using the frameworks of Perry (1970) and Belenky, Clinchy, Goldberger & Tarule (1986), they argue that teachers' understanding of authority, and their related developmental level will

affect their ability to understand and implement teaching based on the constructivist theories which form the backbone of the reform. These sorts of developmental expectations of the reform movement may reflect what Kegan (1994) describes as the broader demands that society has for adults—society's implicit "curriculum"—in the realms of work, relationships, parenting, continuing education, and public discourse, among others.

A small but emerging stream of research examines the curricula of various change programs from an adult developmental perspective. For example, Nadine Ball analyzes how teachers at different developmental positions might understand three Professional Development School reform programs (1997); and Emily Souvaine (1985) employs a developmental model to examine efforts to teach Argyris & Schön's (1974) action theory. This paper joins this emerging stream, looking both at how different professional development programs might be experienced by teachers at different adult developmental positions, and at the implicit expectations and curricular demands of these programs.

The theoretical frame I choose for this analysis is Robert Kegan's constructive-developmental theory (1982; 1994). Like Piaget's work, from which it builds, this theory is constructivist because it assumes that throughout life, people actively construct (rather than passively receive) their understanding of the world through an interaction of new experiences with prior beliefs and knowledge. The theory is developmental in that it sees the nature of these constructions changing in qualitatively different, and progressively more complex, ways over time. Kegan's theory addresses cognitive, interpersonal, and intrapersonal aspects of experience—that is, "thinking, feeling, and social-relating" (1994 p. 32). It also focuses on the complexity of the forms and structures of *how* people organize their understanding, rather than attending to personal styles or the specific content addressed.

Of course, I could pick other theories of development which attend more closely to one or more of these realms of experience (e.g., Belenky et al., 1986; Gilligan, 1982; Loevinger & Blasi, 1976; Perry, 1970) or that describe development proceeding at different

paces within different realms at the same time (e.g., King & Kitchener, 1994). However, I choose to use Kegan's theory because it is broad-ranging and focuses less on the specific content of thought and more on its overall form or structure. Kegan's framework will also serve the theoretical and speculative purposes of this paper, helping me focus on general patterns of experience that may be relevant for analysis and design of teacher professional development programs, rather than attempting to describe the nuances of actual human growth.

Kegan's theory of adult development

Robert Kegan's theory of development (1982; 1994) describes changes in meaning-making structures across the lifespan, but focuses especially on changes which typically occur during adolescence and throughout adulthood. At any of the five stages he posits, there are aspects of ourselves and our world that we can work with, relate to, and have some control over (aspects that Kegan calls "object"); and there are aspects of ourselves and the world that we are made up by, that provide the lens or frame through which we see, that we don't have perspective on because they constitute what we *are* (aspects that Kegan calls "subject"). It is the shifting in these "subject-object" balances that constitutes development. The larger the realm of what we consider "object," the more we can take responsibility for, and the more complex our understanding of ourselves in the world.

The short space I have available will require some caricaturing of these stages, but I hope my descriptions below give a not-too-distorted sense of these differences. For example, young children in Kegan's Stage 1, are "made up by" their perceptions. Reality for them *is* what they see, so that a quantity of water that *looks* different to them actually *is* different. When children come to conserve volume, they find a way to coordinate their perceptions at different points in time within a larger frame. The structure of this new meaning making system, Kegan's Stage 2, is one of "durable categories" in the physical and social worlds. People at this position can coordinate their impulses to describe their own and others' enduring dispositions and preferences: 'I'm a friendly person not just

because I feel happy or have a friend today, but because I've noticed that's true about me in lots of situations and circumstances.' They can coordinate perceptions to conserve concrete qualities. They develop a point of view, and care about how others perceive them because those perceptions may have concrete consequences for them.

The work of adolescence is typically to gain some perspective on these "durable categories" to construct an understanding—Kegan's *Socializing* Stage 3—that can coordinate and integrate them within larger cognitive and social principles (though there are some adults who don't fully make this transition). In this stage, people can coordinate several points of view within a sense of their own role within a social structure. They care about others' opinions of them as such, not just in terms of what that will mean about the others' actions towards them. People at this stage can use abstractions and inference to coordinate concrete data, and can develop hypotheses and respond to abstract ideals and values. The idea of doing things "because it's the right thing to do" even if it's not in your own self-interest makes sense at this stage. Kegan describes this meaning-making structure as "Traditionalist" or "Socializing" in that it includes an internalized sense of mutual reciprocity and cultural expectations, and therefore enables people at this stage to be responsible for their own role within a larger social structure. Many adults think this way and, given contexts which provide appropriate external models for belief and action, adults using this meaning-making system can be quite successful.

However, Kegan argues that our society often demands something more from adults (1994), and these demands serve to move people towards the fourth stage he posits. In this "Modernist" or *Self-authoring* stage, adults come to coordinate their multiple roles and the different expectations others hold for them within their own self-generated, relationship-regulating framework. They aren't "made up by" others' expectations (responding either by cooperating or rebelling) because they have a larger frame from which to judge and make sense of those expectations. People at this stage internally mediate between abstractions through abstract systems and ideologies—e.g., as a middle-manager coordinating job

demands to lay-off workers to increase profits, with a sense of loyalty and obligation both to those who will be hurt by such a move and to those who will stay on. They take responsibility for their own inner states and take a perspective on culturally or socially mediated definitions of reality. Kegan calls this stage *Self-authoring* in that an individual constructing reality in this way can distinguish her own role in shaping her understanding of the world and is not unduly shaped by the cultural milieu in which she finds herself. This way of constructing meaning is the primary mode for a significant minority of adults (Kegan, 1994, pp. 188-197).

Finally, Kegan claims that a much smaller percentage of adults come to see these personally constructed ideologies themselves as constructed objects from a "dialectical" or "self-transformational" perspective (Stage 5). Social relationships from this perspective are characterized by an integration of Self and Other—e.g., 'any aspect of what I used to see as "my" identity is in part defined by the contrast and relationship with what I used to see as "yours."' Conceptual frameworks in this view embrace contradiction and paradox. This perspective is really quite rare, and consequently is difficult to describe.

Development in Kegan's framework does not occur all of a sudden, though particular incidents can be important catalysts for change. Rather, Kegan argues that people move from fully constructing their understanding in a way that is consistent with a particular stage, towards building a bridge to the next stage by constructing meaning in two ways at the same time (though perhaps preferring one over the other), and eventually towards stepping fully beyond the earlier stage by incorporating it into the larger frame of the later stage. Kegan borrows from D.W. Winnicott to describe changes over time in "holding environments" for evolution—environments in which people can be affirmed for where they are, challenged to move beyond it, and supported and nurtured in the growth of a new way of making meaning. An environment can fail to promote development through inappropriate amounts of either support or challenge.

Program Descriptions

In this section I will describe the change goals of three teacher professional development programs and their methods for accomplishing those goals. Selecting three programs to stand for the wide variety of what might count as transformative professional development, even within the more limited field of mathematics teacher education, is difficult at best. Though I've kept in mind the 'socio-cultural, epistemic, and psychic' categories in which transformation of meaning-perspectives can occur according to theorists of transformative learning (Cranton, 1996; Mezirow, 1989; 1991), my emphasis has been on representing a range of exemplary programs within the constructivist focus of the mathematics education reform movement.

The three programs I've chosen—SummerMath for Teachers, the Math Case Methods Project, and the Algebra Project—take different approaches to promoting reform. SummerMath attempts to support a shift in teachers' paradigms about mathematics and learning by asking them to personally engage with and reflect on mathematics and pedagogy. The Math Case Methods Project attempts to support teachers in re-evaluating and complicating their ideas about mathematics and mathematics teaching through collaborative inquiry into practice via mathematics teaching cases. The Algebra Project seeks to change the expectations of teachers, students, and the broader community about who can learn mathematics through community organizing and introduction of new curricular approaches.

I have selected these programs because of their diversity of approaches, because of the availability of written materials about them, and to some extent, because of my familiarity with them.[2] The descriptions below are drawn primarily from the collaborative writings of the teacher educators/ researchers who designed or ran each program—Deborah Schifter for SummerMath for Teachers; Carne Barnett for the Math Case Methods Project; and Bob

[2]I worked as a teacher educator and classroom consultant in the SummerMath for Teachers program from 1987 to 1990.

Moses for the Algebra Project. Because these authors are deeply grounded in the experience of teaching these programs, their writings may better reflect the fundamental perspectives, intentions, and goals of the programs.

SummerMath for Teachers

Founded in 1983, the SummerMath for Teachers program "was one of the first in-service programs to introduce teachers to a constructivist perspective on mathematics education" (Schifter & Fosnot, 1993, p.16). The program has included an intensive, two-week, introductory summer institute; academic year mathematics courses for teachers; regular classroom consultation between teachers and staff; an "Advanced" summer institute; a writing course in which teachers develop reflective case descriptions of their changing practice; and more (Schifter, 1996a; 1996b; Schifter & Fosnot, 1993).

In all these formats, teachers have explored mathematics at their own level; listened carefully to children's thinking about mathematics; explored curricular issues by pondering the essential, underlying "Big Ideas" of mathematics; reflected on and written about their own learning experiences; and planned for changes in their instructional practice based on these experiences. Schifter and Fosnot (1993, pp. 16-18) describe four principles guiding the work of the SummerMath for Teachers program:

1) Constructivist principles of learning apply just as much to teacher education as to student learning in classrooms;
2) Teachers must learn mathematics at their own level to both deepen their conceptual knowledge and give them experiences constructing this understanding themselves;
3) Regular classroom consultation supports ongoing learning "in the context that matters most";
4) Collaboration among teachers is essential as they explore how to turn these new ideas into new practices.

In all of this it's clear that the program does not offer specific techniques or curricula for teachers to follow, but rather, an opportunity for teachers to construct a teaching

practice for themselves guided by new ideas about mathematics and constructivist pedagogy. Teachers are explicitly expected to develop their own knowledge and authority both mathematically and pedagogically. "The premise that continues to underlie all [program activities] is that teachers must identify and examine their enacted assumptions about mathematics and how it is learned and, in the light of new and evolving understandings in these large areas, reconsider their own teaching" (Schifter, 1996a, p.195).

Mathematics Case Methods Project

This project uses facilitated discussions of teacher-written descriptions of classroom experiences to stimulate critical thinking, and development of pedagogical content knowledge. Cases include samples of dialogue or student work and typically end with some kind of problematic or dilemma around which discussion begins. Groups of teachers meet regularly (typically monthly) and discuss a different case each time, though usually focused within the same mathematics content area. Teachers participate in the program not only as learners, but also as case-writers and as discussion facilitators (Barnett & Friedman, 1997).

Barnett claims the program fosters changes in teachers' beliefs about learning and teaching, and in their content knowledge. Built on the "cognitive flexibility and transfer theories" of Rand Spiro and his colleagues (cited in Barnett, 1991; 1988), a case based curriculum helps teachers enter and build connections across the complex terrain of teaching from a variety of vantage points. Within the community of inquiry formed by the case discussions, facilitators "pose strategic questions, press for an analysis of alternative strategies and their consequences, and provoke challenges of opinions, ideas, and beliefs expressed by members of the group" (Barnett, 1991 p. 266).

"The purpose of the Mathematics Case Methods Project is to build the capacity of teachers to make informed strategic decisions that draw on and anticipate student thinking" (Barnett & Friedman, 1997, p. 381). Its power comes from the way it:

- fosters shared authority over the ideas embedded in the cases rather than encouraging reliance on outside authorities for answers;
- generates intrinsic motivation to change, which yields beliefs about practice which are more resilient and robust against potential opposing views because they're self-generated; and
- supports the development of context-sensitive, pedagogical content knowledge (Barnett & Ramirez, 1996).

The Algebra Project

The Algebra Project combines introduction of new curricular materials and teaching methods with "community organizing" to create a transformation of expectations within the culture of the school and the wider school community (Moses, Kamii, Swap, & Howard, 1989; Silva, Moses, Rivers, & Johnson, 1990). By emphasizing the value of confidence and effort over innate ability, as well as offering specific methods to move from concrete experiences through natural language representations and towards symbolic representations of mathematical ideas, the Algebra Project seeks to help *all* children gain access to algebra by the end of eighth grade. This is seen as important to open academic and career opportunities for students, especially those who are typically disenfranchised—particularly students of color and poor students.

Teachers are asked to take on the roles of "coach" and co-inquirer as opposed to "lecturer." In showing what they don't know, thereby risking embarrassment themselves, teachers can model an intellectual openness for students which can lead to new learning. Trainings by the Efficacy Institute ask teachers to raise their expectations for students and to value effort (rather than innate ability) as the prime vehicle for learning. Parents are also offered mathematics workshops and Efficacy Institute trainings and are encouraged to advocate for their children within the larger school system.

Underlying the project is a social constructivist philosophy, and teachers are asked to look for and value pro-social behaviors and attitudes both informally and in formal

assessments. In addition, teachers meet regularly to talk about efforts to change their teaching, and the goals of the project as a whole. In general, the project seems to create an alternative culture which incorporates high expectations for the success of all students; politically situated beliefs about the value of algebra itself; and methods for teaching that ground abstract understandings in concrete experiences. Though the curricular and pedagogical methods are quite prescriptive in many ways, the culture also supports teachers to develop particular practices within the broader values of the project.

> "Bob [Moses] didn't really give us a way, which admittedly was frustrating, but it also gave us ownership around it. Bob didn't have all the answers. At first I was really annoyed... But he knew that it had to come from us. He knew he couldn't impose, because he didn't know what would work. He wasn't a classroom teacher. He just had the vision. If he could help us catch the vision, we could make it work" (Moses et al., 1989, p. 432).

Developmental analyses

These projects have a range of goals for teacher—including changes in knowledge, beliefs, practice, and context or culture. They also have a range of methods for promoting these changes—doing mathematics, reflecting on practice, listening carefully to children, participating in a community of inquiry, generating alternative visions for teaching, internalizing new beliefs, and so forth. However, though they're different in many ways, these projects are all interested in changes in practice that stem from changes in beliefs—beliefs about mathematics, knowing, and learning for SummerMath for Teachers; beliefs about how pedagogy can be grounded in knowledge about students' mathematical thinking for the Math Case Methods project; and beliefs about who can learn and how to teach for the Algebra Project.

We can look at development in the context of these projects in two ways: First, what are the developmental expectations of these programs? What level of complexity in thinking do they expect from their teacher-participants? This is an interesting question about the

intentions and goals of the programs. However, it may be impossible to say for certain what the developmental expectations of these programs are, in part because, as we'll see below, program challenges may be interpreted differently from different developmental places.

A second approach to thinking about development in these projects asks how teachers at different developmental levels could *perceive* the challenges and supports offered by these programs. Independent of the explicit or implicit goals of the teacher-education programs, what kind of environment do they provide for teachers at different developmental positions? This approach will be the focus of my analysis because it attempts to describe the possible variation in the perceptions of teacher-participants in these programs, and therefore offers more potential insights to teacher educators and researchers.

Below, I examine the supports and challenges of the three programs through several developmental lenses. I focus on how the demands of the programs might be experienced by teachers operating from the *Socializing* (Stage 3) and *Self-authoring* (Stage 4) perspectives in Kegan's theory, because the vast majority of adults construct meaning in such ways. I begin by looking at how teachers who are fully Stage 3 and then those who are fully Stage 4 would understand these programs. Next, I present a case of a teacher in transition from a Stage 3 *Socializing* to a Stage 4 *Self-authoring* perspective. Finally, I touch on how those who are transitional from Stage 2 to 3, or from Stage 4 towards 5, might also construct their understanding.

As I consider the perspective on the programs offered by each stage, I hope to shed light on the varied ways that programs might be perceived by teachers who participate in them, and how programs can support growth and development in the full range of their potential teacher-participants.

A "Socializing" perspective

Teachers who construct meaning at Kegan's *Socializing* stage 3 are embedded in a milieu of role expectations. They can see themselves through the eyes of others, and judge

their actions and behaviors based on socially derived values and categories. Teachers at this stage are likely to rely on external authorities to generate images of "good practice" or "right answers" about mathematics or teaching, since they don't have their own internally created framework from which to compare or evaluate alternative practices.

For these teachers, "authority" can come in a wide range of forms. It might include documents such as textbooks, or project materials, or curriculum frameworks, or even video images of teaching that are seen as describing "best practice." People such as district administrators or project directors or other teachers within a community of practice can also serve as authorities, as can culturally accepted rules of thumb about what it means to teach, among others.

Teachers at this stage would be likely to seek affirmation from project staff. They may look to programs to prescribe certain methods, for example, talking about "doing SummerMath" or even just "doing IT" (Schifter & Fosnot, 1993) even when programs' constructivist principles lead them actively to refrain from providing such affirmations or prescriptions. Classroom consultation may seem essential to these teachers in that it brings an expert into their room to tailor the reform ideas to the particulars of their situation.

In this stage, case discussions like those in the Math Case Methods Project, may serve not so much to "develop strategic thinking" capacity but to generate images and rules from a trusted community that can then guide practice. While teachers may be able to generate hypotheses about what's going on in a case, they may get confused when attempting to compare and weigh alternative hypotheses or views.

A curriculum, such as the Algebra Project, can also serve as an authoritative text whose descriptions of activities and methods can guide new practices. The widespread community support offered by the Project for a particular way of viewing children and of teaching would likely feel comforting to teachers making meaning in a *Socializing* way.

If authorities' views of right action compete—for example between the traditional text-book view of mathematics as a transmissible set of skills and procedures, and project-based

views of mathematics as socially constructed and conceptual—teachers at this stage may feel quite torn. They may try to find ways to determine which authority is more "right" and to prefer that view. If they have no reason to believe the claims of one of these competing authorities over the other they may be unsure, even unable, to reconcile these different pulls. This can create emotional turmoil with uncertain consequences on practice. Some teachers in this position may choose to resolve the conflict by being responsible to *both* expectations—teaching both "problem-solving" and "regular" math at different times of day. The Algebra Project's organizing to develop a widely shared set of beliefs about math learning and teaching in the broader school community may reduce the potential for this kind of inner conflict for *Socializing* teachers because this unified environment, where these teachers look to develop and hold views about "right" practice, will offer fewer opportunities for conflicts among authorities and constituencies.

Teachers operating from this structure can make dramatic changes in their beliefs and practices. They may develop deeper understandings of mathematics, learn about how students grapple with mathematical ideas, develop practices for promoting discourse, and come to see understanding as constructed individually or socially. In some ways, they may be able to hold almost all of the beliefs about learning and content sought by the reforms. However their own constructions of these ideas will be shallow, in the sense that they will be internalized images generated from outside authorities, rather than more robust self-generated conceptions that may be able to withstand inevitable pressures to change again.

If teachers at this stage can remain within supportive communities they may grow and thrive, but they may have more difficulty taking the lead in designing new practices to fit underlying principles or to deal with conflicts in values. If the communities of practice they work in oppose the reforms, then these teachers will likely respond similarly. To the extent that reform programs are primarily interested in changes in beliefs and practice *per se*, these teachers may be seen as quite successful. However, implicit in many reform efforts is not

just specific changes in technique but a demand to continuously build teaching practice from new principles. These demands require a *Self-authoring* perspective.

A "Self-authoring" perspective

Teachers who construct meaning at Kegan's *Self-authoring* stage 4 would experience these programs quite differently. The mathematical and pedagogical activities offered would be seen as opportunities to examine and adjust their own theories of learning and ideas about mathematics. They would be unlikely to adopt new ideas or practices without critical reflection, and would likely judge ideas against some internal, self-defined standard—for example, depth of student learning they promote; or support for equity and access.

Teachers at this stage are able to fulfill some of the explicitly stated goals of these projects—to "make informed strategic decisions" about practice built on student thinking; to "examine their assumptions about mathematics and how it is learned and...reconsider their own teaching" in light of that; to "catch the vision," or perhaps consider it and adapt it, and to develop practices consistent with that. These teachers can "balance multiple goals and considerations" (NCTM, 1991 p. 22) as they create a practice which responds to the demands of the reform movement, as well as the local, context-specific demands of the students in their classrooms.

Self-authoring teachers may not agree with the particular ideas and principles espoused by specific programs, and may therefore choose not to incorporate them into their meaning frameworks and thus, their practices. They may also have trouble if ideas are presented as behavioral prescriptions for practice rather than grounded in their underlying premises, or if the premises are unclear (see also Richardson, 1990).

However, when programs ask teachers to reflect on and examine their knowledge and beliefs, *Self-authoring* teachers will likely experience these requests as reasonable opportunities to get at the heart of what it means to teach. The SummerMath for Teachers call for teachers to not only learn mathematics, but also to reflect on their own math learning as a vehicle for developing a constructivist philosophy of learning and teaching

would make sense—standing outside of an experience to use it as data for developing a meta-theory is within these teachers' cognitive capacity. The use of cases as a vehicle for mapping a complex, interconnected but uncertain terrain of practice would also seem reasonable. In fact, these types of structures and opportunities seem to be designed with *Self-authoring* teachers in mind.

The emphasis in both the Math Case Methods Project and in SummerMath for Teachers to get to deep assumptions and premises underlying practice would make good sense to these teachers. New ideas about content or teaching within the "shared authority" generated by group discussions can serve these teachers well to stimulate reflection about the implications and consequences of their beliefs as "enacted." *Self-authoring* teachers would be unlikely to look to program staff or curricular guides for "right answers" or prescriptions of how to teach. Classroom observations and consultations might be perceived as collegial chances to reflect on practices and what they say about philosophy and beliefs.

It is less clear in the writings about the Algebra Project exactly *how* the changes in beliefs about mathematics teaching and learning, and about students' efficacy are fostered among teachers. If they are offered as alternative views whose consequences seem to be beneficial to students, then *Self-authoring* teachers may weigh and consider them against their current beliefs as they decide whether to integrate these ideas into their existing frameworks. But even if they're presented primarily as beliefs and practices to be adopted by the warrant of authority of research or the charisma of the project director, these teachers may still consider them in light of their personal beliefs. However, arguments from authority may be less convincing to these teachers than arguments from values and consequences.

These teachers will be able to do all that these reform-oriented projects are seeking—though they may choose not to. They have an internalized sense of authority which will enable them not only to adopt values and practices generated outside themselves, but to

make these ideas their own. They will be able to function in new situations in ways that are consistent with the underlying premises of the reform. It is these teachers who Cooney and Shealy have in mind when they say:

> "Reform by its very nature, necessitates the asking of questions, the posing of the contrary, and consideration of what is not presently the case. Such a perspective is central to seeing the world in contextual terms, to appreciate that other perspectives are possibilities. Reform is not the product of inertia nor of blind acceptance. To the contrary, it requires a commitment to integrate many varied voices in a rational way ... Reform of the sort suggested by the NCTM Standards requires a relativistic orientation" (1997 p. 104).

Like the majority of adults, though, the majority of teachers may not have fully developed the *Self-authoring* capacities that Cooney & Shealy suggest the reform requires. As we have seen, teachers from a *Socializing* frame are not yet able to coordinate these multiple perspectives and integrate them into a self-generated, coherent whole. Yet *Socializing* teachers can still change their beliefs and practices in ways that are consistent with the reform. To do so, they need the support of a context which will carry those values and generate practices for them.

At the same time, implicit demands to move beyond the *Socializing* frame towards a more *Self-authoring* frame may create tension and turmoil for Stage 3 teachers. This tension can serve as a catalyst for developmental growth, as well as for change in beliefs and practice. In the next section, I examine the case of Sherry Sajdak, whose two year struggle within the SummerMath for Teachers program seems to me to describe both such shifts. This material, developed from Schifter & Fosnot's chapter entitled *The Rug Pulled Out from Under Her*(1993 pp. 104–118), is based on data derived from classroom consultations, Sajdak's own reflective writings, observations and discussions within summer institutes and Schifter's mathematics course for teachers, and research interviews. Sajdak agreed to the publication of the chapter, despite the difficulties it describes, "because

I think it will help other teachers. Had I not felt so alone with all these feelings and failures, I think it wouldn't have felt so bad" (p. 105).

A transition from Socializing to Self-authoring

Sherry Sajdak was a fifth grade teacher who struggled in many ways with the ideas about mathematics and learning raised by SummerMath for Teachers. Schifter and Fosnot describe her conflicts as primarily a clash of paradigms that took two years to resolve. She moved from a traditional view of mathematics as a set of "facts, rules and procedures ... a finished sequence of topics in the mathematics textbook" (p. 106) to a more constructivist view of it as a body of knowledge to be explored. Mathematics teaching, too, shifted from the orderly coverage of "objectives" to "an active process of discussion and debate, of making and communicating sense" (p. 117).

These are important, deep, substantive shifts in understanding of mathematics, learning and teaching. Yet Schifter and Fosnot also hint at a change not only in Sajdak's ideas, but also in her "developing recognition of her own authority and control over her practice" (p. 113)—i.e., a change in her relationship to these ideas. Essentially, the shift they describe is from a reliance on external authorities to describe and judge "right" practice towards an internalized conception of teaching and mathematics—a shift which can also be described as development from a *Socializing* to a *Self-authoring* frame.

Sajdak came to the program expecting "SummerMath would give me the bag of tricks to quietly, painlessly perk up teaching math" (p. 107). She relied on the authority of the textbook, of her past math professors, and the program staff (when possible) to know how to teach. The program, instead, asked her to focus on her own internal sense of understanding of the mathematics, and on an assessment of the impact of teaching practices on students' understanding. For a *Socializing* teacher this was a strange paradox, as the authorities were asking her to be more *Self-authoring*.

At first, she was at a loss to know what to do with these new ideas, feeling as though "the rug had been pulled out from under her" (p. 112). Having been shaken up by the

initial summer institute, she experimented occasionally with implementing particular practices in her classroom—e.g., cooperative groups, "problem-solving" sessions, and manipulative materials. Though unsuccessful at first, over the course of several months, her reflections on the use of these techniques led to more successful modifications. Yet, like many other teacher-participants, she was still stuck in her *Socializing* "desire to 'do it right'" (p. 113). Paradoxically, it was only "when she gave herself permission to reject the techniques she had learned in the institute that Sherry discovered what *she* believed and wanted to do" (p. 114, original emphasis).

At this point, Sajdak seemed to be simultaneously constructing her understanding in both a *Socializing* and *Self-authoring* way. She hadn't fully given up reliance on outside authorities, but was beginning to develop her own internalized sense of theory and practice. This was an important step, but Sajdak went further still. "Having 'received permission' from others and, more importantly, from herself to accept or reject new teaching strategies, Sherry had next to release herself from the power of internalized images of authority—authors of textbooks, her own mathematics teachers, SummerMath for Teachers staff—in order to assume responsibility for her own learning" (p. 114). In time, she came to see herself as the primary agent in deciding on best practices, paying less and less attention to what she was "supposed to do" and more to the subtleties of what it meant to teach for understanding.

Working in a second, "Advanced" summer institute and with the support of a consultant for a second academic year, Sajdak was able to solidify these changes in her thinking though, as she described it at the time the chapter was written, she was not yet "there." Referring to the role of correct answers in a contextually driven curriculum, she said, "I can't quite convince myself! This new information clearly should replace the old, but I'm having trouble letting go of the old way, even though I fully agree with the new way" (p. 117). It's not clear whether her unresolved conflict was now among different views of mathematics and pedagogy within a solid sense of what she was seeking, or

whether she hadn't fully consolidated the structural and developmental changes in her thinking initiated by participation in the program. Yet even if the latter is true, she is clearly able to manage the conflict in a different, more *Self-authoring* way than before the program.

Though I can't be certain based solely on these case materials, it seems that Sherry Sajdak's story not only represents an example of a teacher in an adult developmental transition, but also hints at the possibility that programs can support adults to make such changes in their broader meaning-making structures. Though not explicitly intending to promote her broader adult development, SummerMath for Teachers seems to have provided an appropriate mixture of supports and challenges to enable Sherry Sajdak to broaden her perspective and take deeper responsibility for her beliefs and practices—at least within the realm of mathematics teaching about which we have evidence—even as she also changed the content of her beliefs about the nature of mathematics, of learning, and of teaching.

Other transitional positions

According to Kegan, the vast majority of adults make meaning within the three developmental positions I've sketched out above—a *Socializing* frame, a *Self-authoring* frame, and the transition between the two. However some adults construct meaning from other developmental positions as well, and I will briefly describe how teachers in these positions might perceive the three programs. Specifically, I will describe how teachers in the transition between a stage 2 *Durable categories* frame and a stage 3 *Socializing* frame might view the programs; as well as the perspective of those who are beginning to move beyond a stage 4 *Self-authoring* frame towards a stage 5 *Self-transformational* frame.

Teachers who still construct meaning within the transition between a *Durable categories* (Stage 2) frame and a *Socializing* (Stage 3) frame will be oriented towards the socially sanctioned views and practices of the programs, but also towards the concrete consequences to them of participating in the project and adopting particular practices. These teachers may participate as much to get stipends, or to avoid district imposed sanctions, or

to find teaching techniques that will make their jobs easier, as to fulfill their obligations and roles in the eyes of authorities. These teachers will likely be oriented towards following mathematical rules or pedagogical rules of thumb and therefore may struggle to understand some of the abstract concepts espoused by programs, or to test hypotheses about practice raised by them. Classroom consultations may be viewed primarily as the program sending a representative to check on whether desired teaching is occurring, and these teachers may "perform" at such times to avoid getting caught doing something "wrong." This is not to say that only teachers at this developmental position attend to these sorts of rules and consequences—on the contrary many teachers do. However teachers in the Stage 2 to Stage 3 transition are still made up, in part, by these consequences; the consequences may be *all* they see rather than being integrated into a larger framework of values and roles.

Teachers who are moving beyond a *Self-authoring* (Stage 4) frame towards a dialectical, *Self-transformational* (Stage 5) frame are beginning to gain perspective on the very principles underlying their own self-authored view of the world. These teachers might engage in a community of discourse in a different way than a *Self-authoring* person, defending their own position less, and seeing alternative principles and views as holding an aspect of the truth that can be integrated into a still larger whole. They might develop a critique of how a program chose to communicate its values and ideas, or of why a particular set of principles might not be universally appropriate. They might describe their problems as dilemmas of practice and develop a way of teaching that enables them to manage, but not resolve, these dilemmas (e.g., see Ball, 1993; Lampert, 1985).

Though these two positions are rarer, they are not unheard of among participants in teacher professional development programs. I hope these brief sketches point to some of the essential structures of these meaning-making systems and their potential impact.

Conclusions & Implications

While this analysis has been theoretical and speculative, I hope that it points successfully towards how teachers at different developmental stages might experience the

goals and activities of several transformative mathematics teacher professional development programs. I hope to have shown that differences in developmental frames may result in vastly different experiences of "the same" program. In addition, though I haven't delved deeply into this, it seems clear that the goals and methods of different programs may serve teachers at particular developmental positions better than others, and programs may even assume or at least, hope for, a particular level of cognitive complexity.

Exploring these differences in how programs are perceived by teachers, and in what programs expect of teachers, could be useful both for teacher educators designing professional development programs, and for researchers seeking to understand these programs. We can use the developmental theory in at least two important ways: 1) to understand better how to support teacher-participants at a variety of developmental positions; and 2) to examine whether broad-based development itself, as described here, is or should be one of the explicit goals of teacher education programs.

Supporting a range of teachers

Even if programs would like teachers to develop a self-authored view of mathematics and teaching, teacher education programs don't (and shouldn't) screen participants for a minimum developmental level. Instead, the transformative ideas about mathematics, learning, students' thinking, teaching, and the nature of community which form the basis of these programs must be offered appropriately to teachers at a wide range of developmental levels. But how can programs design curriculum appropriately to meet the needs of teachers at different development levels?

Tacitly or explicitly, teacher education curricula may speak best to one or another of these developmental positions. However, teacher educators considering the implications of these speculations might seek to develop structures that would support teachers simultaneously at *several* developmental positions. Many activities already described in the literature may in fact support teachers at different developmental positions, though these haven't typically been identified as designed with development in mind. For example,

curricular or pedagogical suggestions can be made (to support *Socializing* teachers who want suggestions for best practices) within the context of critical reflection on their effectiveness in promoting students' mathematical thinking (for *Self-authoring* teachers to examine underlying values). Classroom consultations might be shaped to provide more or less directive supports for different teachers. Teachers in their discussions together might both generate and affirm the potential of new ideas and practices for *Socializing* teachers, while also examining their underlying warrant for those who are more *Self-authoring*.

Though these ideas are not new to teacher education practice, recognizing explicitly how they can be shaped to serve the needs of teachers at different developmental levels can enhance their effectiveness. Clearly more work could be done to elaborate the implications of this theoretical perspective on the design of teacher education programs.

Clarifying goals

We have seen above that teachers at a variety of developmental positions can develop teaching practices consistent with the current reform visions, although they construct their understanding of those practices in qualitatively different ways. In addition, I think it is possible to design teacher education activities that will speak well to teachers at a range of developmental positions. However, in the end, I don't think it is enough to provide *Socializing* teachers with external images of best practices for them to merely adopt. In part, the complexity and situatedness of teaching requires an ability to generate new practices from underlying, guiding principles on a regular basis. That is to say, we just don't know, nor can we always predict, what "best practices" are. While *Socializing* teachers may be able to get the supports they need from a broader community to generate "good enough" practices, they may not be able to generate it themselves without such supports. This view of teaching would imply that professional development programs should include, among their goals, the promotion of *Self-authoring* ways of thinking.

Clearly, we can't just assume teachers will act in *Self-authoring* ways without support for development itself. If we are expecting teachers to make developmental shifts in the

structures of their meaning making systems, we should think carefully about how to support them to do so. Some of the techniques described above that promote transformation of the *content* of teachers' beliefs and knowledge can also serve to transform the *structure* of how teachers hold those beliefs. For example, reflecting on underlying assumptions about learning can serve both to support a shift in teachers' epistemological paradigms, as well as their relationship to that knowledge.

But we could be more explicit and intentional about understanding and designing such processes. That is, we could work to identify mechanisms which support developmental transitions and design them into our teacher professional development programs. An example of such a mechanism arises in the paradox experienced by those in a *Socializing* frame when they see programs "telling them" to "think for themselves." While this may seem paradoxical, it may also provide exactly the right bridge to support development; anchored on one end with an acknowledgement of where *Socializing* teachers are now—happy to be told by authorities how they should think and behave—and on the other with an image of where they might go. Further work identifying and designing such mechanisms is needed.

Finally, holding development itself as a goal for teacher professional development has implications for the overall design of such programs. At least, they must extend over a long period of time to have any hope of being effective; and they must be flexible in the supports they provide to nurture people as their developmentally driven perspective changes.

Further research

Though these speculations about the impact of a developmental theory on teacher education practice are interesting, they also clearly require a more empirically grounded base to be validated. Research could be conducted which would examine the adult developmental level of teachers participating in professional development programs, and describe the changes they make in their beliefs, knowledge, and practices; the supports and challenges they experience within programs that lead to these changes; and other aspects of

how they make meaning of the professional development experience. Do the broad developmentally based patterns hinted at in this paper actually emerge among real teachers? What other patterns of perception or behavior do we find and how can they be explained?

This work also points towards the need for a fuller and deeper analysis of the developmental curricula of a variety of teacher professional development programs. What are their goals and expectations for changes in thinking? In what ways are these goals a matter of changing particular ideas (content), and in what ways are they a matter of changing the very way in which ideas are held (developmental structure)? Analyzing these goals might be difficult since a program's expectations for a particular developmental level are likely to be implicit, but a careful analysis of goals and criteria for evaluating success might begin to uncover these distinctions.

This paper also points towards ideas which may be useful in thinking about the relationship between efforts to change teachers' internal beliefs, and efforts to change the cultural context in which those beliefs develop. In this analysis, the cultural change approach is best represented by the Algebra Project, while the more cognitive approach is highlighted by say, SummerMath for Teachers. In fact, this tension has been discussed of late in the broader theoretical literature. Sfard (1998) offers a strong version of this tension in her description of an "acquisition metaphor" which focuses on internal changes in knowledge and thinking, and a "participation metaphor" which focuses on more and more central participation in a community of practice. Richardson (1990) tries to bring these together by pointing to the dual roles of *autonomy*—a key to individual change—and *alternative perspectives* generated by communities of teachers examining the premises underlying their actions.

Notwithstanding the complex philosophical and pedagogical theories underlying these views, this paper raises the possibility that a developmental perspective may help explain the different ways in which these two different approaches to promoting learning are useful among adults. Specifically, changing the cultural context may have a differentially strong

effect on learners acting from a *Socializing* perspective. Providing opportunities to examine and re-evaluate assumptions and beliefs may be particularly well suited to those who are more *Self-authoring*. This is clearly an oversimplification of the applicability of these two perspectives—they are different lenses for looking at learning that can be applied across the lifespan. Yet, further theoretical analysis and empirical research might help illuminate whether this speculative seed would bear fruit upon closer examination.

It is my hope that as both teacher education practitioners and researchers further explore the implications and issues raised by these speculative ideas, that we will gain a deeper understanding of the role of adult development in the ongoing work of educating teachers.

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